

Introgression of Blue Eggshell Color from a Gene Bank Collection into a White Leghorn Breeding Line

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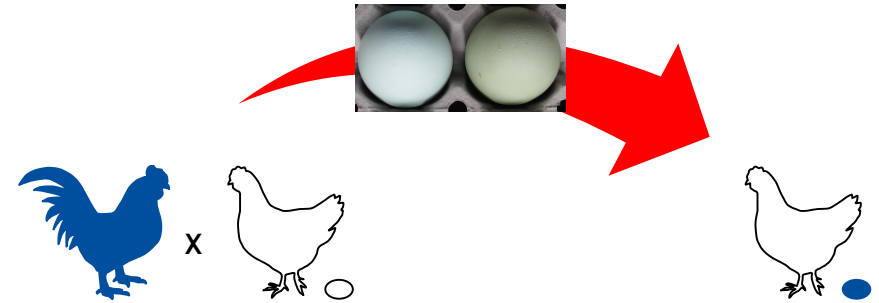


Objectives

- Demonstration of usefulness of genebanks



- Model for Introgression



- High performing blue layer line



<https://www.lincolnshirelive.co.uk/news/local-news/egg-cellent-lj-fairburn--1186811>

British Blue

Free Range Blue & Brown



<https://happyegg.co/>

Chicken eggs different colors

- **Brown**
Protoporphyrin-IX storage in the cuticula of the eggshell



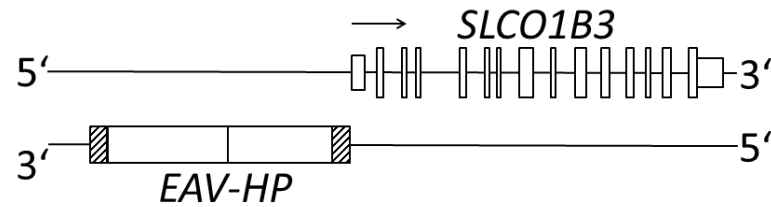
<http://www.virology.ws/2013/09/11/a-retrovirus-makes-chicken-eggshells-blue/>

- **Green/Blue**
Biliverdin, Biliverdin-Zink-Chelat storage in the eggshell and in the cuticula of the eggshell

- **White**
Calciumcarbonat Matrix

Genetic of blue eggs

- Dominant trait, retroviral insertion on chromosome 1 at 65.22 Mb upstream of *SLCO1B3*, induces overexpression of *SLCO1B3* in the oviduct (Wang et al., 2013, Wragg et al., 2013)D

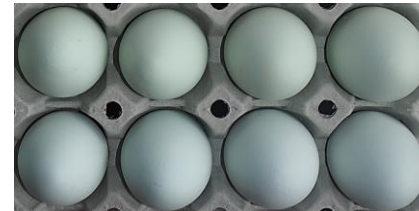


Modified after Wang et al., 2013

- *SLCO1B3* encodes a biliverdin transporter → biliverdin increases → storage in eggshell

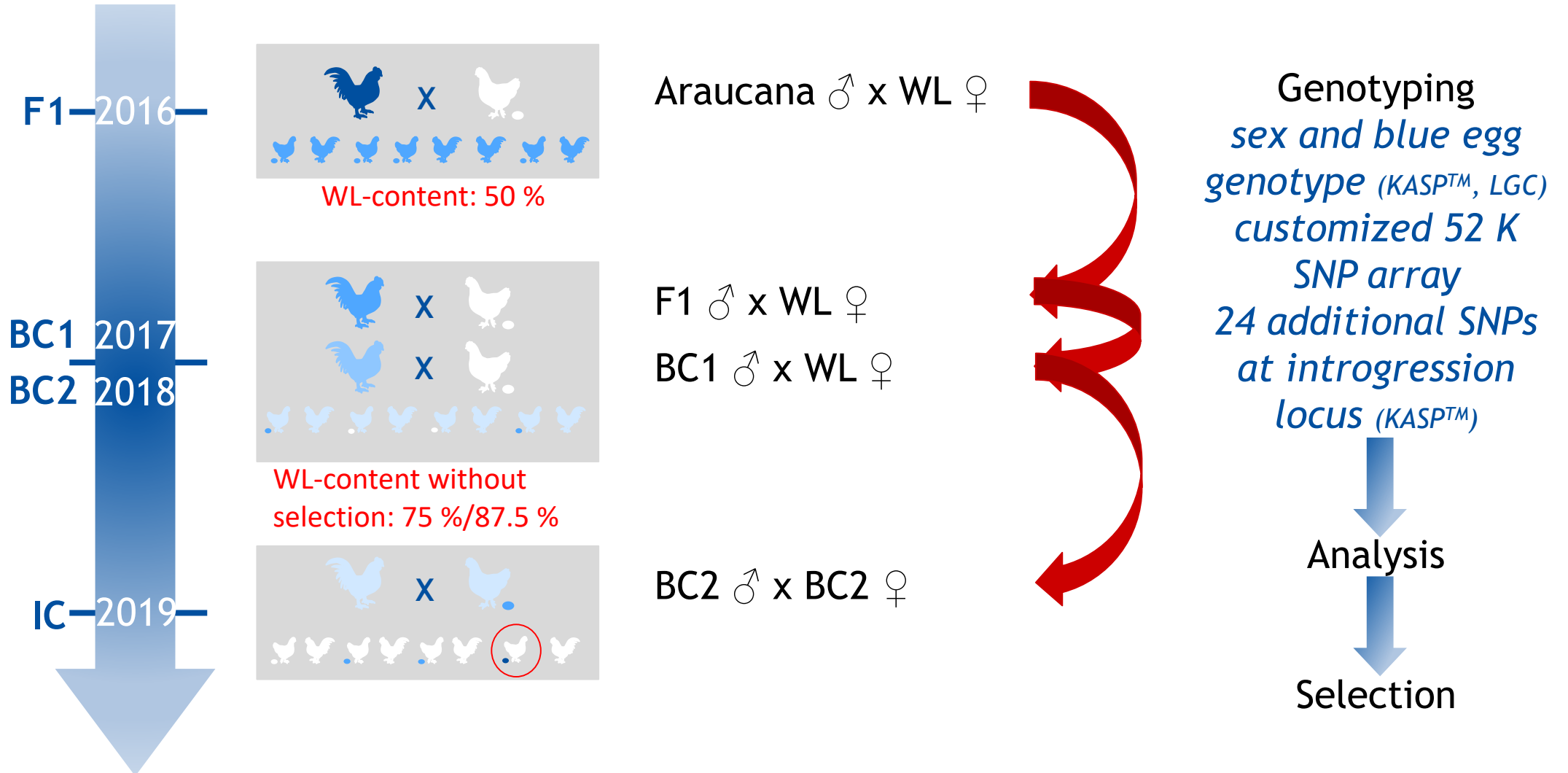
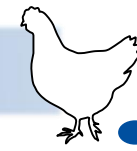


Homozygous (BB)

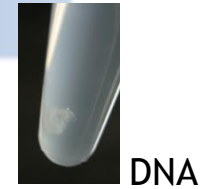
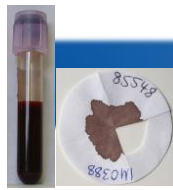


Heterozygous (Bw)

Experimental design



Genotyping



N = 6



Whole Genome Sequencing (WGS)

Founder



580K Affymetrix SNP Array

N = 10

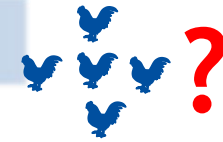


24 breed/line specific SNPs at introgression locus (chr. 1, 60 - 71 Mb)



Possibility to detect recombinant animals on the basis of these breed/line specific haplotypes

Selection criteria



- WL haplotypes at introgression locus



Chr. 1: 60-71 Mb
65.22 Mb



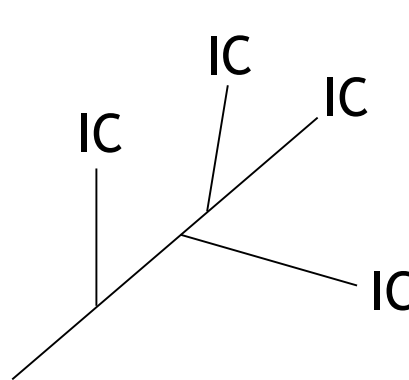
Detection of recombinants using Merlin 1.1.2. (Abecasis et al., 2002)

- High similarity to the recipient WL line genome-wide

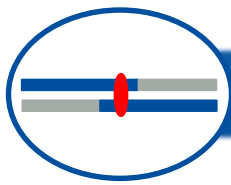


Meksafe (Marker estimated kinship, safe set)
MoBPS (Modular Breeding Program Simulation)

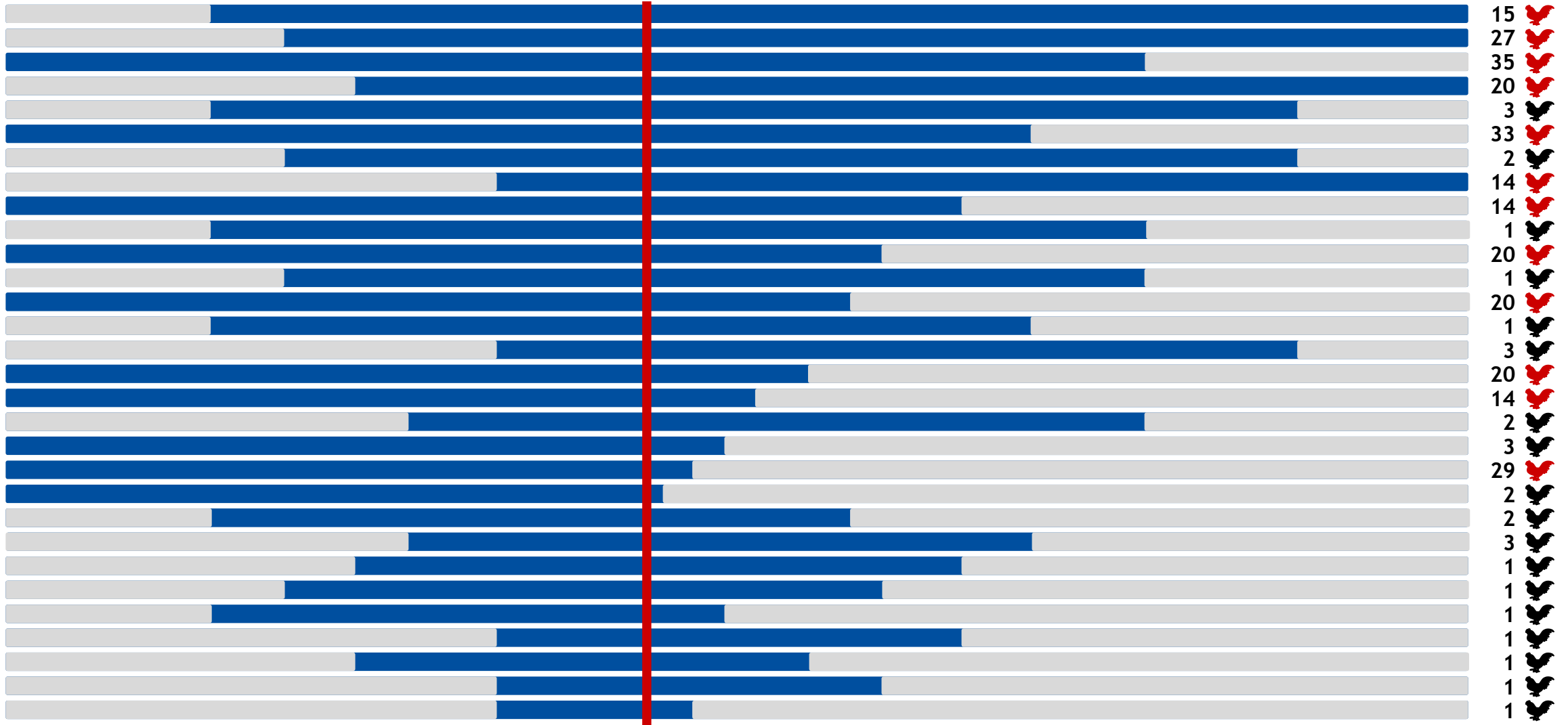
- Maximum diversity



- All cocks for the mating of the BC2 were selected out of the recombinant BC1 cocks!



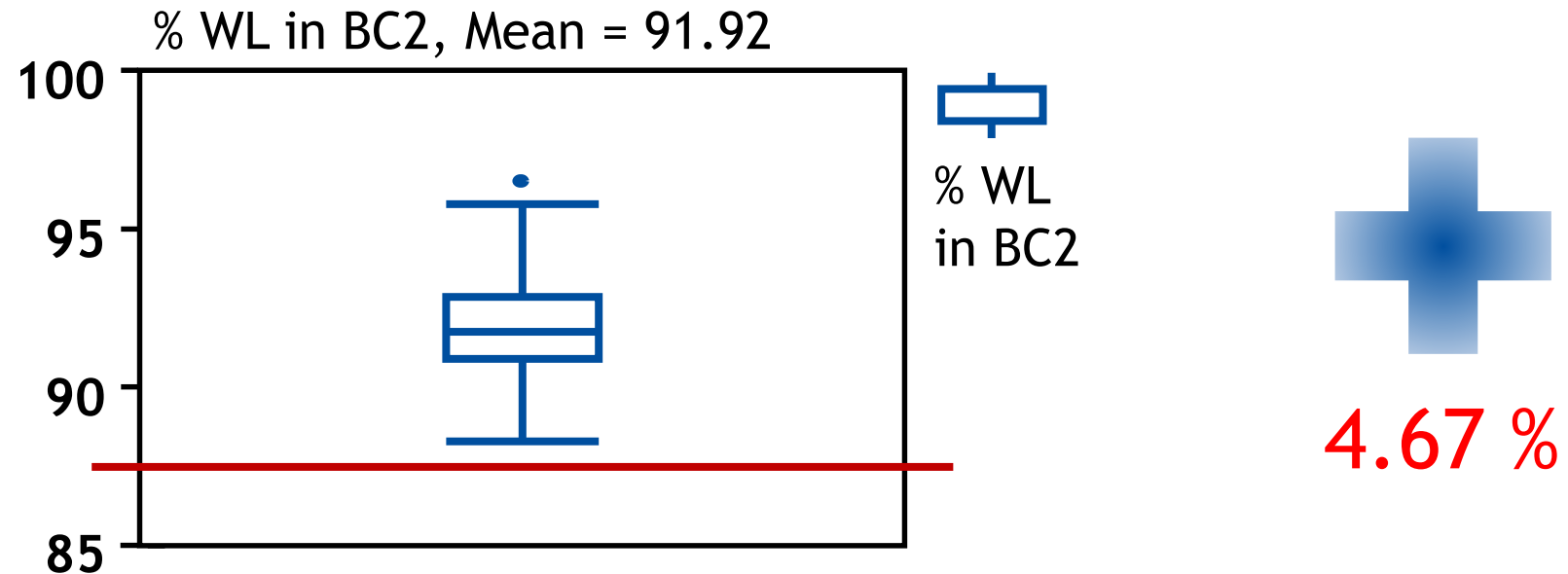
Detection of recombinants in the BC2



White Leghorn content



- Mean % of WL was estimated on the basis of founder specific SNPs



- Higher than expected without selection up to 96.48 %

Intercross Selection



- Animals available at time of selection:

111 cocks (Bw)
145 hens (Bw)



Excluded:
ww, †, laying
performance < 70 %

- Ranking according to:

Maximum WL-content at
introgression locus,
preference of double
recombinant animals



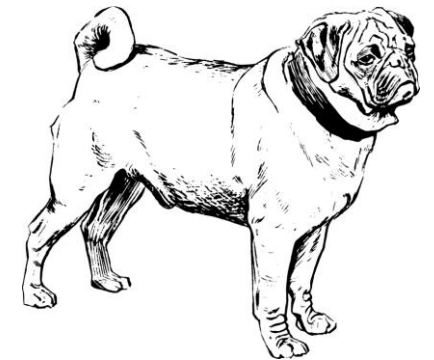
Rated equally

Maximum WL-content
genome-wide

- Animals selected for simulation studies

60 cocks (Bw)
120 hens (Bw)

What
next?
MoBPS!!!



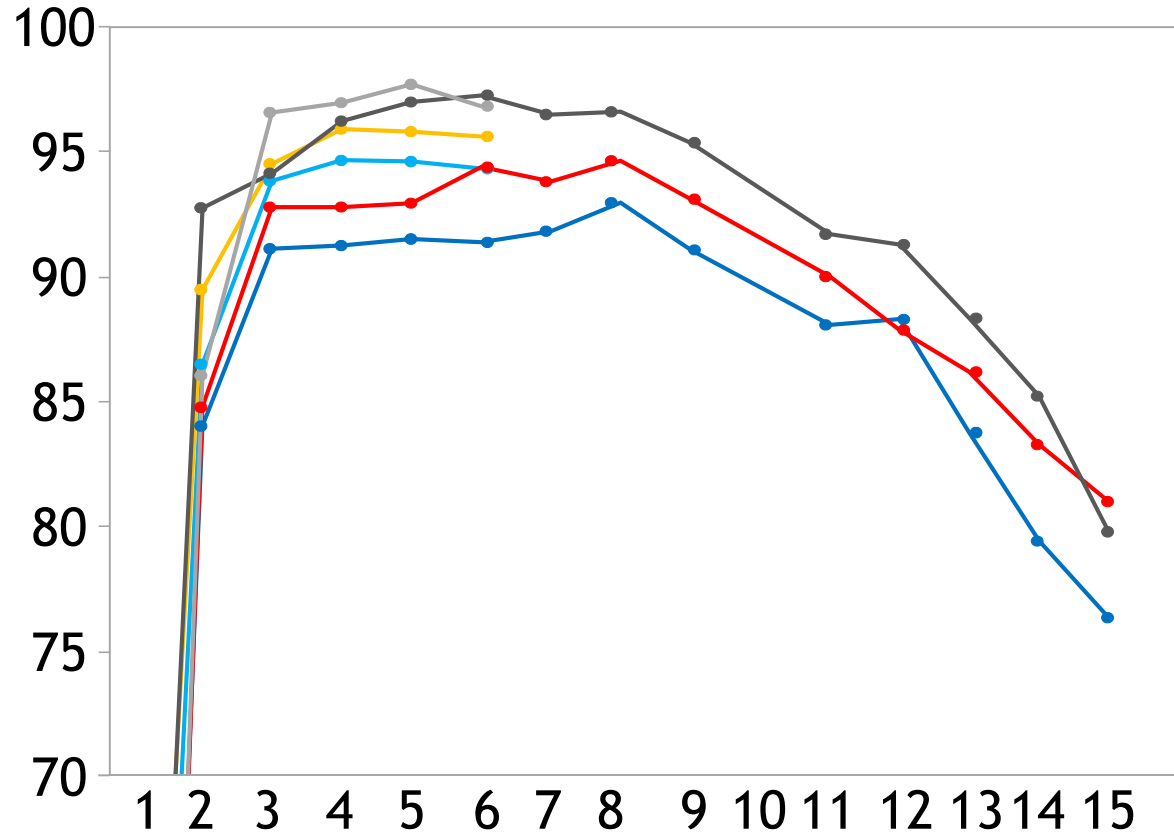
Mating of 20 cocks and 100 hens (1:5) on the basis of the results of MoBPs

Performance tests

- Per group (F1, n=37), per individual (BC1, n=234, BC2, n=234 and controls)
- LW20 - LW79, BC2 still in progress
- Mortality
- Total egg number and laying rate
- Egg quality (*egg weight, eggshell strength (FUTURA Egg-Shell-Tester) and eggshell color (Konica Minolta Reflectometer CR 300)*)

Performance tests - laying rate

Laying rate in %



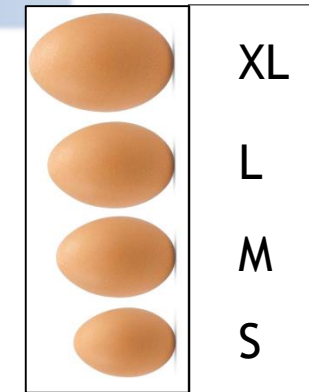
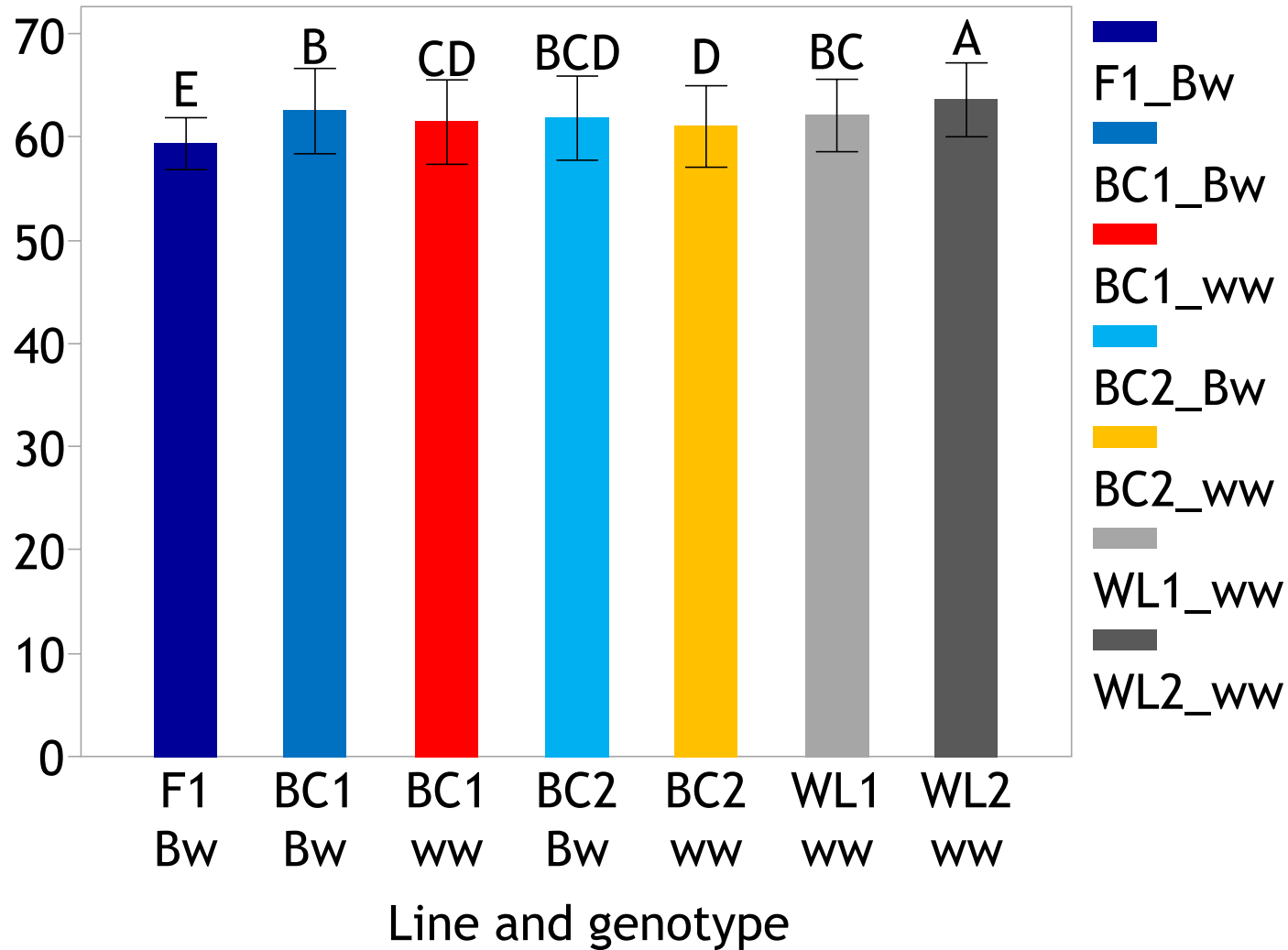
— WL_2
— WL_1
— BC2_ww
— BC2_Bw
— BC1_ww
— BC1_Bw

Productivity interval of 4 weeks, start in LW20

- Laying rate of carrier slightly lower than of non-carrier
- Laying rate of BC2 higher than of BC1

Egg weight

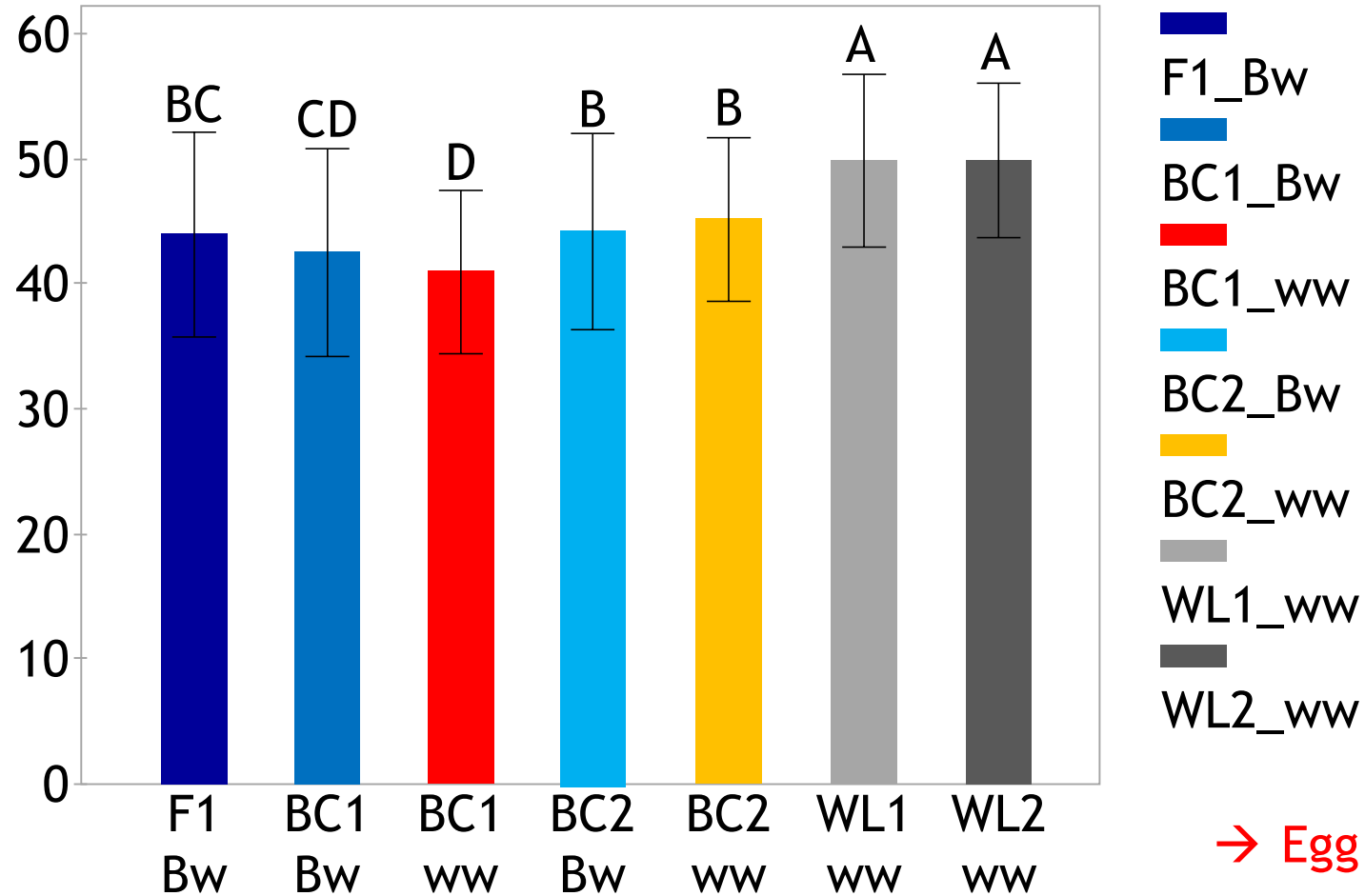
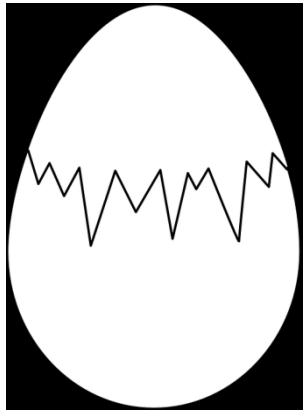
Mean egg weight of LW40/49 in g (+/- SD)



→ All eggs of the back crossing generations reach the size M or L

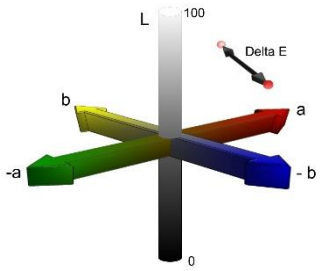
Egg shell strength

Mean egg shell strength of LW45/49 in Newton (N) (+/- SD)

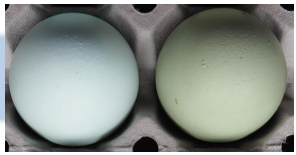


→ Egg shell strength improved in the BC2

Line and genotype

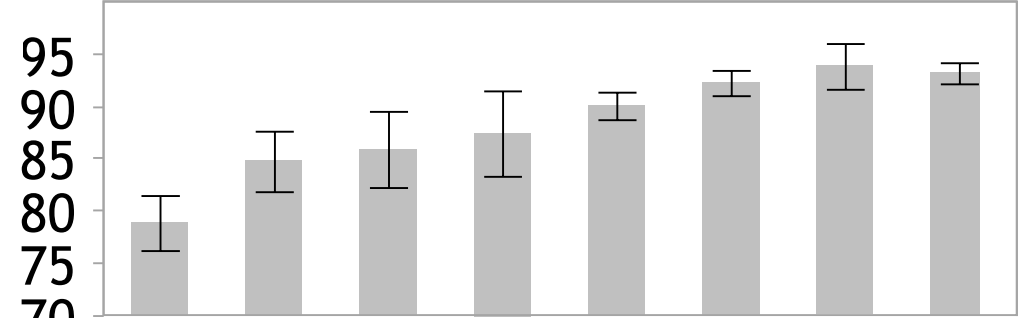


Egg shell color - Lab

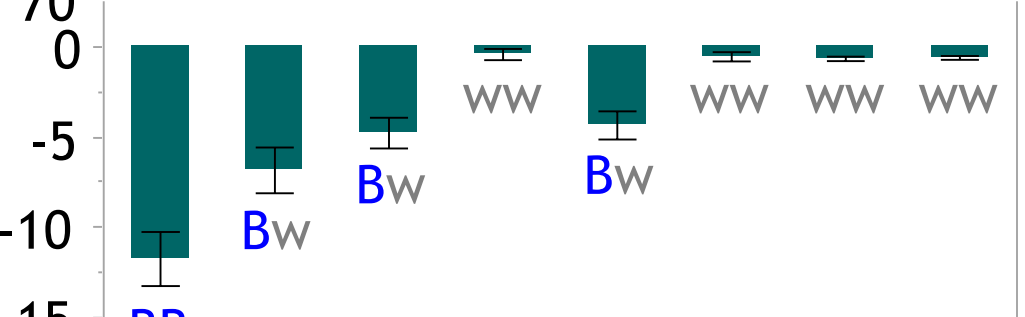


Araucana
BB

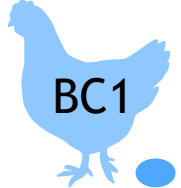
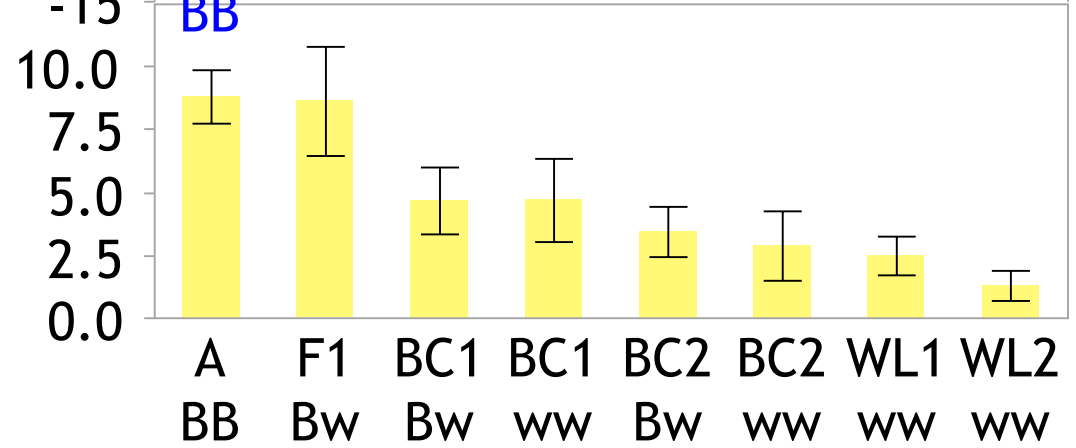
Mean L
lightness



Mean a
green -
red



Mean b
yellow -
blue



→ Green value is influenced by the genotype
 → More White Leghorn content leads to increased lightness and decreased yellow color in our population

Summary/Outlook

- Marker-assisted introgression leads to an increased WL genome in the BC2 (+4.67 %)
 - Laying rate increases with a higher WL content, non-carrier BC2 similar to WL
 - Laying rate of carriers is slightly lower than of non-carriers
 - Egg weight of the back crossing generations is similar to WL (~ 62 g)
 - Egg shell strength of the back crossing generations is significant lower than in WL (~ -5-10 N)
 - Egg shell strength of the BC2 increased compared to the BC1 (~ + ~4 N)
 - Other loci seem to influence the egg shell color in our population
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- **Selection of animals for the final IC, hatching November 2019**
 - **Final analyses of BC2 and IC performance tests when finished**
 - **Analyses of genotyping results of hens with regard to performance data**

Acknowledgments



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 677353.

Entire staff of the Department of Breeding and Genetic Resources



All collaborative partners of the IMAGE project

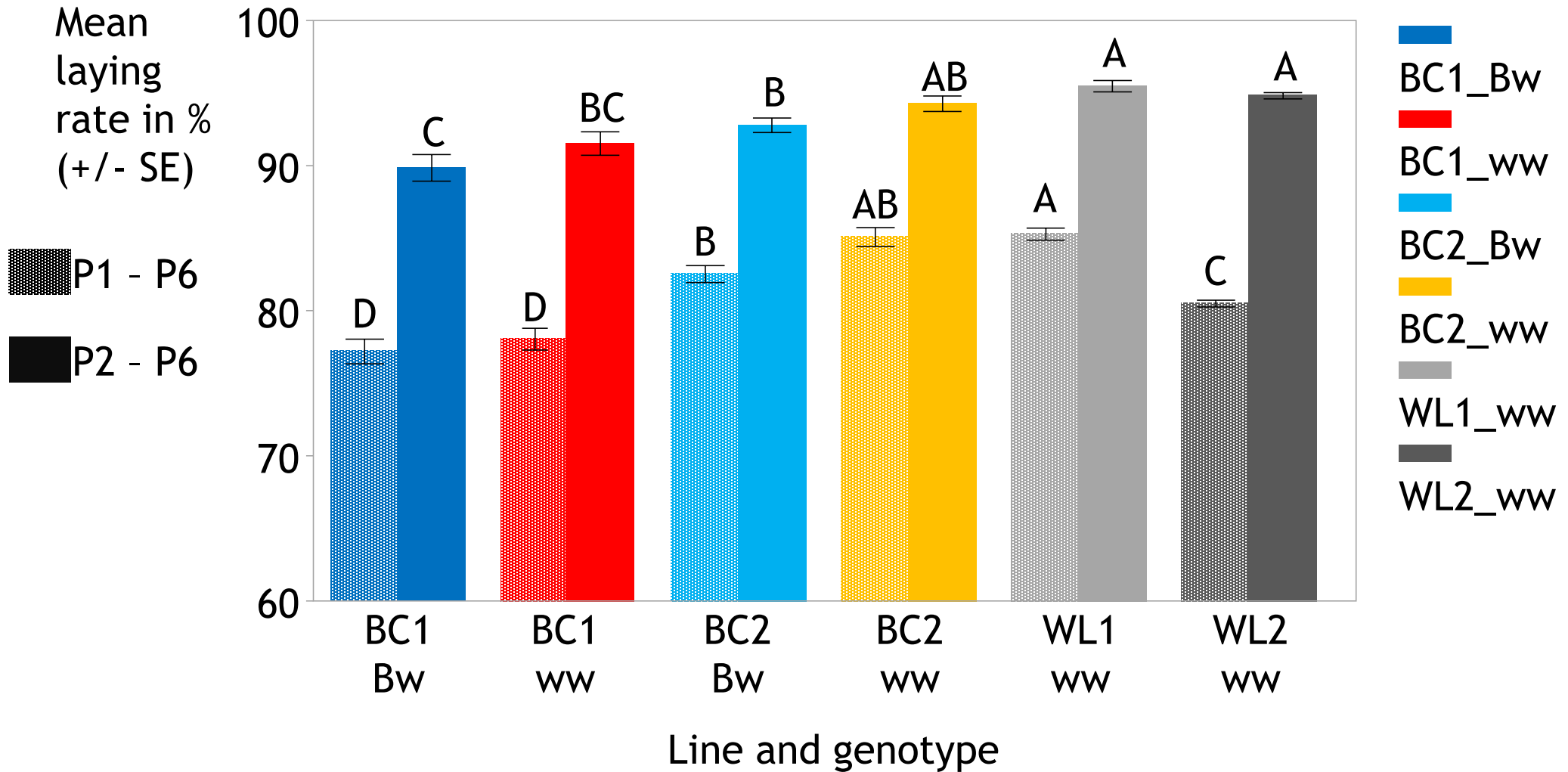


Our project partners for the very good cooperation



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Performance tests - laying rate



Performance tests - laying rate

Sum of mean laying rates in % (+/- SE) P1-P6

Productivity interval of 4 weeks, start in LW20

